Figure 1b shows a block diagram of an apparatus 1 according to the invention, in which the calibration of the filter 5 and thus the calibration of the apparatus 1 are carried out by means of a second signal from an image processing device 2 (image processor) which is included in the image acquisition device 7 or is connected thereto.

Figure 2 corresponding to the block diagram of Figure 1b shows an apparatus of this type with the image processing device image processor being connected to the calibration input of the filter 5 in the case of a scanning electron microscope. The image acquisition device 7 (image acquirer) acquires at least one pixel of the object and supplies the image processing device 2. As in the case of the first embodiment, the signal of the sensor is fed forwards to the deflection coils 3a, 3b. A signal for driving the calibration input of the filter 5 is generated in the image processing device 2. The calibration of the filter 5 and thus of the apparatus 1 is described below with reference to two different embodiments.

According to a first embodiment, the microscope 1 is set up for operation in a calibration mode and an image mode, whereby, in the calibration mode, ambient influences that reduce the imaging quality can be detected by the imaging of a predetermined reference object and comparison of the image with the real structure of the reference object, and can be essentially eliminated by calibration of the microscope 1, and the imaging defects are greatly reduced or essentially compensated for, even in the event of a change in the ambient influences, by maintaining the calibration in the image mode. Depending on the operating mode, the input signal of the calibration input of the filter 5 either depends on the respective measured imaging defect (calibration mode) or is obtained by means of the data stored during the

calibration mode (image mode). It is possible to switch back and forth between the calibration and image modes.

The calibration mode is utilized in order to detect ambient influences, that is to say in this case the electromagnetic interference field which reduces the imaging quality, by the imaging of a predetermined section of a reference object and comparison of the image with the real structure of the reference object, and to calibrate the apparatus in such a way that systematic imaging defects caused by external ambient conditions and/or caused by instrumentation are essentially compensated for. According to the invention, this calibration of the microscope 1 is carried out by setting the transfer characteristic of the filter 5. Figure 3 illustrates how the scanning device (scanner) scans a selected section of a reference object in the calibration mode, in which case, in the digital image processing device 2, a stored signal assigned to the reference object is compared with the image signal of the reference object that is obtained from the image acquisition device 7 (image acquirer), and a signal assigned to the difference is formed and is output to the calibration input of the filter 5.

The calibration method in the calibration mode can be described by the following steps:

- determination of a first signal, which depends on the electromagnetic interference field at the location of the sensor, by a sensor 4;
- application of the first signal to the signal input of the filter 5;
- acquisition of a selected section of a predetermined reference object by means of an image acquisition device 7 (image acquirer) by scanning the reference object;
- comparison of the acquired image with the real structure of the reference object;

- determination of a defect signal assigned to the difference;
- application of the second signal, derived from the defect signal, to the regulating input of the filter 5 for defining the transfer characteristic of the said filter;
- application of the output signal of the filter 5 to the signal input of the regulating amplifier 6;
- application of the output signal of the regulating amplifier 6 to the electron beam detection coils 3a, 3b (Figure 2) for the purpose of correcting the reduced image quality;
- iterative calibration of the characteristic of the filter 5, in such a way that the reduction of the imaging quality is greatly reduced or essentially compensated for, by means of the following steps:
- comparison of the corrected image with the real structure of the reference object
- alteration of the transfer characteristic of the filter 5 in such a way that the corrected image approximates to the real structure of the reference object;
- storage of data for generating the determined transfer function of the filter 5 for the image mode.

In one embodiment, these data for generating the determined transfer function of the filter 5 for the image mode are stored in a memory assigned to the image processing device 2. In a further embodiment, the filter 5 is set up for storing these data. While the imaging defect is being determined, the devices for compensating for the imaging defects (compensators) are switched off. The microscope 1 according to the invention is then calibrated by the method described above, that is to say the feedforward for the measurement signal of the sensor is set as a measure of the interfering quantity.

The compensation quality is measured by repeated scanning of the reference object and comparison of the image with the real structure of the reference object. By determining the compensation quality in each case and correspondingly changing the transfer function of the filter, the feedforward is iteratively changed in such a way that the imaging defects of the scanning electron microscope are minimized.

The microscope 1 can be calibrated with regard to location- and/or time-variable imaging defects.

For this purpose, a reference object as shown in an exemplary fashion in Figure 3 is scanned on a predetermined path in the calibration mode. The imaged reference object comprises circular gold deposits which have been deposited on a substrate and are arranged in a predetermined manner. The scanning device of the microscope is driven externally, with the result that a selected section of the reference object is acquired. This path may, for example, be closed like that shown by the curve 9. Individual objects 8 are situated on this closed path, to which objects the image acquisition device 2 (image acquirer) responds and generates a signal not equal to zero. This is shown schematically and by way of example in Figure 4, which illustrates the signal profile 10 acquired at a given instant t_i during the traversal of the closed curve 9. Time-dependent interference can cause time-dependent imaging defects. For this reason, in the illustration of Figure 4, the closed curve has been traversed four times at intervals. The resulting four signal profiles 10 are thus also a measure of the temporal dependence of the interference. Furthermore, the traversed curve is altered by varying the radius R, whereby location-dependent imaging defects can be detected. According to the invention, the time- and/or location-dependent imaging defects are determined by comparison of the

image in the image processing device (image processor) 2 with the predetermined reference object, which is known exactly. In the example represented in Figure 4, the time-dependent imaging defect is illustrated by the curve 11.

The image mode is the operating mode of the inventive scanning electron microscope 1 in which the actual sample is measured. The filter 5 transfer characteristic determined in the calibration mode is invariant during the subsequent image mode with regard to the characteristic defined in the calibration mode. As explained above, however, it can vary with respect to time and as a function of the scanning location.

Assuming an essentially constant correlation between the electromagnetic interference field and the imaging defect caused by this interfering quantity, the output signal of the filter 5, after passing through the regulating amplifier 6, is applied to the electron beam deflection unit 3, with the result that image defects are essentially compensated for even in the event of a change in the ambient influences, that is to say the strength of the electromagnetic interference field.

In an embodiment developed further, in addition to the electromagnetic interference fields, air vibrations and/or ground vibrations are also detected by corresponding sensors 4, the signals that are output pass through calibratable filters 5 which are assigned to the respective instances of interference and have adjustable transfer characteristics, and, after additional matching in the regulating amplifier 6, are applied to the deflection unit as a further control signal and/or to other actuators, with the result that the imaging defects caused by air vibrations and/or ground vibrations are also greatly reduced or essentially compensated for.